

## TOOL 4. HOW TO DEVELOP FEASIBILITY-LEVEL INFORMATION

### INTRODUCTION

As noted in Tool 1, the evaluation of proposed solid waste management systems (containing new alternatives) by various technical and economic/cost criteria is essential to determining those most appropriate for use.

This tool presents details on technical and economic/cost criteria used for a SWM feasibility analysis. Also presented is information on how to obtain the necessary data and conduct the analysis. Examples of analyses and useful results is provided as well.

### DETAILED DISCUSSION OF TECHNICAL & ECONOMIC/COST CRITERIA

#### Technical Criteria

The technical criteria that should be considered in choosing between solid waste management alternatives include:

- Effectiveness in achieving objectives
- System compatibility
- Environmental effects
- Land use requirements
- Resource conservation
- System reliability/longevity
- Facility siting
- Regulatory compliance
- Implementation timing.

#### Effectiveness in achieving objectives

All SWM alternatives should be scrutinized to determine if they will help the community meet the established waste management objectives. This will ensure that SWM planners select alternatives that are consistent with identified needs and goals.

- **The evaluation of proposed systems with new alternatives by various technical and economic/cost criteria is essential.**

- **SWM alternatives should help the community meet the established waste management objectives.**

Diverting wastes from landfilling is frequently an objective in SWM planning today. However, other objectives may include providing for long-term disposal capacity, reducing public risk, assurance of reasonable costs, etc. The effectiveness of different waste management alternatives and the resulting SWM systems in meeting objectives is a major factor in comparing and choosing between these alternatives.

#### **System compatibility**

System compatibility refers to how well the various components of the waste management system work with each other. In an integrated system it is important that waste management alternatives be chosen and designed to complement one another. For example, recycling, composting, and waste-to-energy are compatible if they are not designed to process the same waste. In fact, it has been shown that municipal solid waste remaining after recovery of recyclables can have a higher per ton heat energy value than MSW before recovery (Artz, 1991).

#### **Environmental effects**

Environmental effects of modern waste disposition alternatives, including combustion and landfilling, are expected to be minimal. Still, all possible negative environmental effects should be investigated to ensure that the most effective and safe method is chosen and to mitigate public concerns.

Of the SWM alternatives, waste reduction and recycling are judged as preferable to disposal alternatives in avoiding environmental harm. However, recycling should not be considered a "risk free" option because recycling involves reprocessing or remanufacturing materials which generates residual waste.

- **The effectiveness of different waste management alternatives and the resulting SWM systems in meeting objectives is a major factor in choosing between these alternatives.**

- **It is important that waste management alternatives be chosen and designed to complement one another.**

### Land use requirements

If landfilling is the only SWM alternative in use, land use requirements will be high. The lack of available land in some areas for new or expanded landfills is one of the driving forces behind today's greater emphasis on integrated solid waste management. Diverting wastes from landfilling is maximized when waste reduction, recycling, and combustion are all used in a solid waste management system. Although of varying local interest, conservation of other natural resources can also be maximized by using these waste management alternatives. Teton County's lack of available land for landfilling has caused county residents to transfer their refuse more than 90 miles to a landfill in Sublette County. This has also been a significant incentive for county residents to recycle.

### Resource Conservation

Waste reduction and recycling conserve energy, materials, and land. Waste reduction measures conserve resources by not putting waste into the management system and by reducing the need for new products. All components of solid waste management use energy, including recycling; therefore, any reduction in the amount of waste processed will reduce energy usage.

Recycled materials reduce the amount of virgin resources required to manufacture new products. In general, energy requirements of manufacturing are also less when recovered materials are used in place of virgin raw materials (Franklin Associates, Ltd., November, 1994). Finished compost, put back into the growing cycle, provides nutrients to the soil. Waste-to-energy (W-T-E) is also an energy conservation measure that helps reduce the use of fossil fuels and landfill space.

- **Recycled materials reduce the amount of virgin resources required to manufacture new products.**

### System Reliability

System reliability and lifetime factors need to be considered in planning an integrated system. While more complex SWM systems have greater potential for problems, one-dimensional systems may not meet certain waste management objectives. For example, a SWM system which consists of only collection and landfilling has the greatest reliability.

A system which includes recycling, WTE facilities, and landfilling may be able to meet more waste management objectives. However, recycling and waste-to-energy facilities will sometimes have mechanical failures that may necessitate bypassing processible wastes to a backup component in the system. Decisions will need to be made as to the degree of redundancy to design into each element of the system to prepare for both equipment downtime and seasonal changes in waste quantities. The landfill will always be the element of last resort and may need to be designed for considerably greater waste quantity fluctuations than in a landfill only system.

### Facility Siting

Several factors need to be considered when locating solid waste management facilities; these include:

- Location near the collection area(s) to minimize travel distances
- Access roads capable of handling truck traffic
- Appropriate zoning
- Community acceptance.

While siting new landfills is usually very difficult, siting any facility that processes MSW can meet with varying degrees of public resistance. A regional system approach can be an advantage in dealing with this issue since fewer facilities may be needed.

- **Decisions will need to be made as to the degree of redundancy to design into each component of the system.**

- **Siting any facility that processes MSW can meet with public resistance.**

- **Obtaining necessary permits for a solid waste management system will require effort and time.**

A regional system may allow the use of certain options not otherwise affordable in smaller communities. For example, a materials recovery facility may not be economically viable in a community of 10,000 but such a facility serving several such communities will be far more cost effective. Thus, more types of facilities may require siting with a regional approach (see Tool 12 for regionalization options). The number of facility sitings may still be fewer if different facilities can be located together.

### Regulatory Compliance

Regulatory compliance increases in complexity with increasing use of waste management alternatives and facilities. Obtaining necessary permits for a solid waste management system that includes a materials recovery facility (MRF), W-T-E facility, and landfill will require considerable effort and time.

### Implementation Timing

Since, at least, some solid waste from an integrated solid waste management system will ultimately be landfilled, this may have a bearing on implementation scheduling. Assuring the availability of a landfill that meets regulatory requirements is of first priority. (Typically, three years would be required from the "go" decision for a new landfill to final implementation.) It may be advisable to proceed next with system components that can be effective in the near term—e.g., yard trimmings composting is of comparatively low technical complexity and can potentially be implemented quickly.

### Economic/Cost Criteria

SWM planners must also evaluate the costs associated with SWM alternatives. In some cases, costs are the most important criteria used in making these choices. The net cost of a solid waste management system is determined by the three basic cost elements described below.

- **Yard trimmings composting is of comparatively low technical complexity and can potentially be implemented quickly.**

- **SWM planners must also evaluate the costs associated with SWM alternatives**

### Capital Costs

Capital costs may be considered as long-term investment costs required to pay for facilities and equipment. In SWM, capital costs are incurred for collection vehicles as well as various facilities and associated equipment used in the disposition of the waste. Capital costs can vary substantially depending upon the type of SWM system and facilities used. At one end of the spectrum, waste-to-energy facilities may require an initial investment of well over \$100,000 per ton of daily capacity. At the other end, landfills require a much smaller initial investment even with the new landfill standards.

Financial risk increases directly with the amount of capital investment and the period of time required to retire the investment. Thus, the risk attendant to capital costs can impact choices of waste management alternatives. If, for example, two different waste management alternatives appeared equal in all respects except capital costs, the one with lower capital costs would be favored because of lower risk.

Capital costs may be annualized for purposes of cost estimating and estimating loan payments on borrowed capital. Annualized capital costs are a function of the investment amount, the time period over which the investment is to be retired—usually a function of the expected life of the facility/equipment purchased—and the percentage rate of return on investment capital judged appropriate.

If the investment amount is borrowed, annual or more frequent payments will normally be made to the lender. The annual (debt service) payments will reflect a loan period and interest rate (i.e., rate of return) and may be considered as the annualized capital cost. This might be inappropriate, however, if the loan period does not reasonably reflect the life of the investment property.

- **Annualized capital costs are a function of the investment amount, the investment time period, and the rate of return on investment.**

### Operating and Maintenance Costs

A number of on-going expenditures are necessary to keep a SWM system operating. These include costs for labor, fuel, repairs, utilities, taxes, insurance and general maintenance. Costs will also be incurred for landfill closures, environmental monitoring and post-closure care at completed landfills. Although these latter costs will not be daily occurrences, they will need to be provided for as part of on-going costs.

Operating and maintenance (O&M) costs are usually the most expensive part of SWM. Annual O&M costs may simply be considered as the sum of O&M costs occurring over a year's time.

### Revenues

SWM systems that include recycling or waste-to-energy may have revenues from the sale of recovered materials or energy. Recovered waste paper grades and glass, metal and plastic containers usually have value once they are processed for sale to dealers or end-user markets. Waste-to-energy facilities may produce either steam or electricity for sale. Electric utilities are required to purchase electricity offered by waste-to-energy plants at prices that reflect the utilities avoided cost for that electricity.

## INFORMATION ON OBTAINING DATA & CONDUCTING ANALYSIS

### Technical Analysis

The SWM systems/scenarios chosen for review should be evaluated with respect to the technical criteria described above. While quantitative evaluations may not be possible, information found in this tool and elsewhere should be sufficient to rank the scenarios by each criterion.

Table 4-1 is an example of how technical criteria rankings may be presented to compare the scenarios. Each scenario would receive a ranking

- O&M costs are usually the most expensive part of SWM.

- Recovered materials usually have value once processed for market.

- The technical criteria are an important part of the SWM system selection process.

**Table 4-1**

**RANKING OF PROPOSED  
SOLID WASTE MANAGEMENT SYSTEMS  
BASED ON TECHNICAL CRITERIA**

Technical Criteria	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Effectiveness in Achieving Objectives							
System Compatibility							
Environmental Effects							
Land Use Requirements							
Resource Conservation							
System Reliability/Longevity							
Facility Siting							
Regulatory Compliance							
Implementation Timing							

\*Rank each system from 1 to 3 (1 = highest)

number from 1 to 3 (1 = highest) relative to each criterion. Summing the numbers shown for each scenario would be one approach to determining the best scenario based upon the technical criteria—the scenario with the lowest total winning. This approach, however, assumes that each criterion should be given equal weighting in the comparison when, in fact, some will likely be deemed more important than others. For example, conservation of landfill space may seem more critical in highly populated metropolitan areas than in more rural settings where far more undeveloped land exists.

The technical criteria comparisons are therefore somewhat subjective and not always conclusive. Despite this limitation, they are still an important part of the SWM system selection process.

The information obtained from ranking the scenarios should be combined with the results of the economic/cost analysis discussed below.

### **Economic/Cost Analysis**

As noted previously, total SWM system costs must be considered when comparing waste management alternatives. When adding a recycling or other alternative to an existing SWM system, the cost of the alternative must be added to the cost of that which remains of the old system. This will be necessary to determine if the new system has, in fact, increased or reduced total SWM costs.

For example, in a system where SW is all collected for landfilling, there are two system elements for which costs will be incurred—refuse collection and landfilling (Figure 4-1). If a recycling program is added, total system costs will include recyclables collection and processing plus remaining refuse collection and landfilling (Figure 4-2). The reduction in refuse disposed will generally not result in a proportionate reduction in refuse collection and landfilling costs. Thus, a comparison of per ton costs from the old system

- **Comparing costs of SWM systems being considered for future use requires developing detailed costs estimates on each.**

- **SWM system costs must be considered when comparing waste management alternatives.**

Figure 4-1  
MSW flow-diagram for landfill disposal

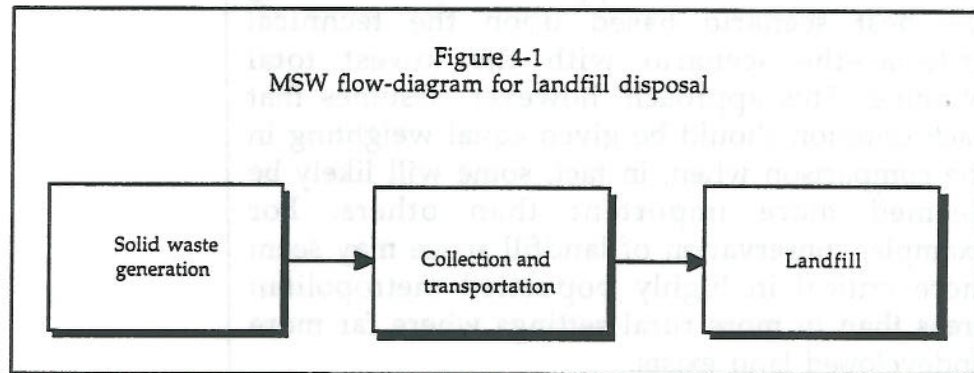
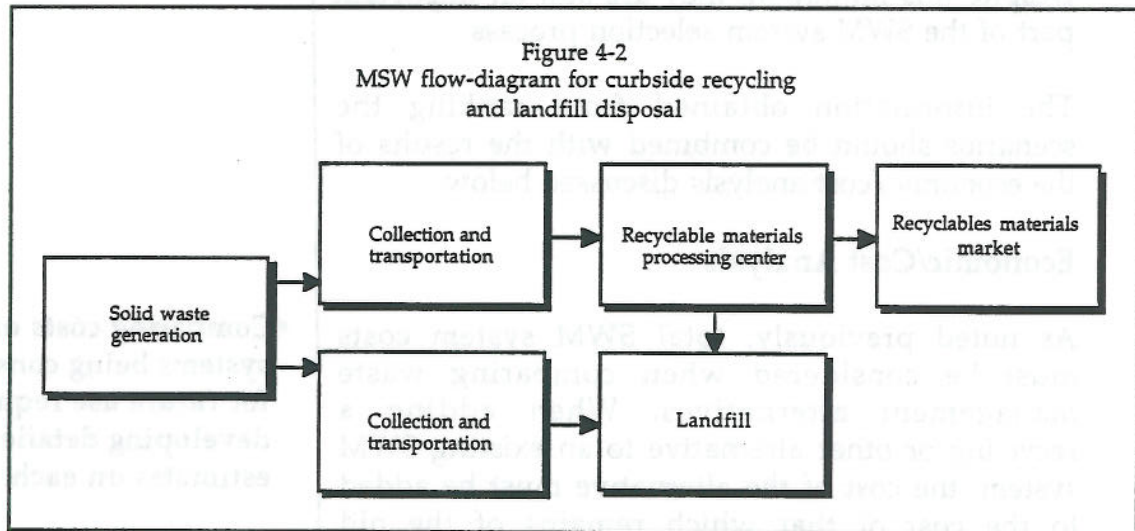


Figure 4-2  
MSW flow-diagram for curbside recycling  
and landfill disposal



with those for recyclables collection and processing (less revenues) will not show whether total SWM costs are more or less with the new system. Instead, refuse collection and landfilling costs must be recalculated for the new system and added to the recyclables recovery costs. Total costs for both systems can then be compared.

Comparing costs of SWM systems/scenarios being considered for future use requires developing detailed costs estimates on each. Capital costs, operating and maintenance costs, and revenues (if any) must be included. These must be developed for each system element including collection, processing, landfilling, etc. Needed cost data may be obtained from equipment vendors, recycling markets, existing system operators, literature sources, and consultants. Adjustments should be made for conditions specific to the geographic area for which the SWM system is being considered—for example, labor costs in Wyoming communities may be quite different from those in large cities along the east coast.

Another Wyoming-specific factor is financial assurance for solid waste facilities, which may be provided only through the following:

- Surety bond
- Federally insured certificates of deposit
- Cash
- Government securities
- Self-bond (in limited instances)
- State financial assurance trust account.

Knowledge of local conditions and published sources may be used to make the cost estimates area-specific.

Some examples of detailed cost estimates for collection of refuse and recyclables, recyclables processing, and landfilling are shown in Tables 4-2 through 4-4. Costs shown, including capital costs, are annualized; total annual costs are then translated into dollars per ton of waste/recyclables handled. The net costs for each element of a SWM

• **Adjustments should be made for conditions specific to the geographic area for which the SWM system is being considered.**

• **The net costs for each element of a SWM system must be added together to arrive at total system costs.**

system must be added together to arrive at total system costs.

The results of SWM system costs analyses will need to be summarized for comparative purposes. In comparing residential SWM systems, "bottom-line" costs presented in dollars per ton and dollars per household are of primary interest. Table 4-5 is an example of how costs estimated for a hypothetical community of under 25,000 population may be summarized. Estimated first-year costs are shown for three alternative residential SWM systems: 1) landfilling only; 2) curbside recycling and landfilling of remaining refuse; and 3) curbside recycling plus yard waste composting and landfilling of remaining refuse. For the first system, the total costs of collection and landfilling all single-family household SW (less bulky items) are shown in dollars per ton and monthly dollars per household. In the second and third system scenarios, total costs are shown separately for wastes landfilled and those recovered for recycling and composting. Together, these costs result in the total system costs shown for managing single-family household SW.

In addition to first year costs, it may also be useful to develop life cycle cost estimate comparisons. These could show a different order of costs for the scenarios considered—particularly for large capital expenditure scenarios with annual costs that include levelized debt service payments. Since the debt service payments are not subject to escalation from inflation, these scenarios may look more cost attractive in later years. However, other factors being equal, high capital cost scenarios also involve increased risk.

- In addition to first year costs, it may also be useful to develop life cycle cost estimate comparisons.

**Table 4-2  
SAMPLE TABLE**

<b>ESTIMATED HOUSEHOLD SOLID WASTE COLLECTION COST</b> (route size of 2,500 households per week)	
<b>Capital Cost Items:</b>	<b>(\$)+</b>
Truck Chassis & Body — 25 cubic yard rear-loading packer	125,660
Spare Trucks — assume 15% backup	18,849
Total Equipment Capital Cost	144,509
<b>Annual Cost Items:</b>	
Truck Amortization — 8 years life, no resale, 6% Int.	23,271
Insurance, Licenses, Taxes, Etc. — 10% of truck capital costs	14,451
Maintenance (Repairs, Fuel, Tires) — \$14.50/hour	30,276
Subtotal Annual Truck Costs	67,998
Labor (2-man crew) — \$11.25/hour each + 48% fringes	69,530
Workman's Compensation — \$1400/year/person	2,800
Labor Supervision — \$3.75/hour	7,830
Overhead (Building & Utilities) — 4% of above annual cost items	5,926
Overhead (Administration, Office) — 10% of above annual cost items except Bldg/Util	14,816
Subtotal	168,901
Profit @ 10%	16,890
Total Annual Cost	185,791
Cost Per Hour	88.98
<b>Cost Per Ton Factors:</b>	
7 tons/load X 1.55 loads/day = 10.86 tons/day/crew	10.86
Cost per day = Cost/hour X 8 hours/day = \$	712
Cost Per Daily Ton	65.56
Cost Per Household Per Month	\$6.19
†Dollar values are for illustrative purposes only. Values should be community specific.	
Source: Franklin Associates, Ltd.	

Table 4-3  
SAMPLE TABLE

ESTIMATED RECYCLABLES PROCESSING CENTER COSTS WITH CURBSIDE SORT RECYCLING PROGRAM 3,900 TONS PER YEAR	
	Costs (in dollars)†
<b>Capital Cost Items:</b>	
Land — 1 acre @ \$10,000/acre	10,000
Site Development Costs: surface preparation, fencing/gates, utilities, buildings.	351,300
Equipment Costs: scales, rolling stock, baler, installation, etc.	167,107
Engineering & Construction Management — use 8% of site development costs & non-rolling stock equipment costs	36,152
Startup Expenses — 1% of site development & non-rolling stock equipment costs	4,519
Interest During Construction — use 2% of site development costs, non-rolling stock costs, & engineering costs assuming 6 months constr.	18,964
Legal & Financial Costs — 5% of site development & non-rolling stock costs	2,950
<b>Total Capital Cost</b>	<b>590,992</b>
<b>Annual Cost Items:</b>	
<b>Debt service Costs:</b>	
Land — 6% interest only	600
Site Development — 20 years life, 6% interest (includes Site Devel. Costs, Engin. & Const. Management, & Interest during Const.)	35,433
Other Financial Debt — 20 years life, 6% interest (includes Startup, Debt Service Reserve Fund & Legal & Financial Costs)	651
Front end Loader, Forklift — 7 years life, no resale, 6% int.	6,180
Other Equipment — 10 years life, no resale, 6% interest	13,668
<b>Subtotal: Debt Service</b>	<b>56,533</b>
<b>Operating &amp; Maintenance Costs:</b>	
<b>Labor:</b>	
Owner/Foreman(1) — \$6.10/hour + 40% fringes	17,832
Equipment Operator (1) — \$5.58/hour + 40% fringes	16,311
Baler/crusher operator (1) — \$5.58/hour + 40% fringes	16,311
Maintenance & Clean-up (1) — \$5.58/hour + 40% fringes	16,311
<b>Subtotal: Labor Costs</b>	<b>66,766</b>
<b>Insurance:</b>	
Equipment — 5% of equipment capital costs	8,355
Buildings — 2.5% of building capital costs	7,918
<b>Subtotal: Insurance Costs</b>	<b>16,273</b>
<b>Property Taxes:</b>	
Equipment — 2.9% of equipment capital costs	4,846
Site — 2.6% of site development & land capital costs	9,394
<b>Subtotal: Property Taxes</b>	<b>14,240</b>
Equipment Maintenance — 4% of equipment capital costs	6,684
Site & Bldg Maintenance — 1% of site development costs	3,513
Fuel — 0.2 gal/ton @ \$1.20/gal	936
Utilities — electricity 15KWH/ton @ \$0.04/KWH, + water 70gpd/person @ \$2.00/1000gal, + heating .025 MBTU/ton @ \$4.00/MBTU	2,876
Residue Disposal — 0% residue (0 tons) @ \$35/ton	0
Public Education & Promotion — \$1/ton	3,900
Overhead (Administration, Office) — 10% of above	17,172
<b>Subtotal: Operating &amp; Maintenance Costs</b>	<b>132,359</b>
<b>Subtotal: Debt Service + O &amp; M Costs</b>	<b>188,892</b>
Profit @ 10%	18,889
<b>Total Annual Cost</b>	<b>207,782</b>
<b>Cost Per Ton</b>	<b>53</b>

†Dollar values are for illustrative purposes only. Values should be community specific.

Source: Franklin Associates, Ltd.

Table 4-4  
SAMPLE TABLE

ESTIMATED MATERIAL RECOVERY FACILITY COSTS 26,000 TONS PER YEAR	
	Costs (in dollars)†
<b>Capital Cost Items:</b>	
Land — 5 acres @ \$65,000/acre	325,000
Site Development Costs: surface preparation, fencing/gates, utilities, buildings.	1,535,800
Equipment Costs: scales, platforms, conveyors, rolling stock, balers, installation, etc.	1,650,066
Engineering & Construction Management — use 8% of site development costs & non-rolling stock equipment costs	213,232
Startup Expenses — 2% of site development & non-rolling stock equipment costs	53,308
Interest During Construction — use 3% of site development costs, non-rolling stock costs, & engineering costs assuming 12 months constr.	86,359
Debt Service Reserve Fund — 11.5% of site development & non-rolling stock costs	306,521
Legal & Financial Costs — 5% of site development & non-rolling stock costs	133,270
<b>Total Capital Cost</b>	<b>4,303,556</b>
<b>Annual Cost Items:</b>	
<b>Debt service Costs:</b>	
Land — 6% interest only	19,500
Site Development — 20 years life, 6% interest (includes Site Devel. Costs, Engin. & Const. Management, & Interest during Const.)	160,018
Other Financial Debt — 20 years life, 6% interest (includes Startup, Debt Service Reserve Fund & Legal & Financial Costs)	42,991
Front end Loaders, Forklifts — 7 years life, no resale, 6% int.	26,870
Other Equipment — 10 years life, no resale, 6% interest	164,414
<b>Subtotal: Debt Service</b>	<b>413,793</b>
<b>Operating &amp; Maintenance Costs:</b>	
<b>Labor:</b>	
Foreman(1) — \$15.50/hour + 40% fringes	45,310
Heavy Equipment Operators (4) — \$12.40/hour + 40% fringes	144,991
Scaleman (1) — \$8.00/hour + 40% fringes	23,386
Maintenance & Clean-up (1) — \$8.00/hour + 40% fringes	23,386
Sorters (10) — \$8.00/hour + 40% fringes	233,856
<b>Subtotal: Labor Costs</b>	<b>470,928</b>
<b>Insurance:</b>	
Equipment — 5% of equipment capital costs	82,503
Buildings — 2.5% of building capital costs	34,528
<b>Subtotal: Insurance Costs</b>	<b>117,031</b>
<b>Property Taxes:</b>	
Equipment — 2.9% of equipment capital costs	47,852
Site — 2.6% of site development & land capital costs	48,381
<b>Subtotal: Property Taxes</b>	<b>96,233</b>
Equipment Maintenance — 4% of equipment capital costs	66,003
Site & Bldg Maintenance — 1% of site development costs	15,358
Fuel — 0.2 gal/ton @ \$1.20/gal	6,240
Utilities —electricity 15KWH/ton @ \$0.04/KWH, + water 70gpd/person @ \$2.00/1000gal, + heating .025 MBTU/ton @ \$4.00/MBTU	18,819
Residue Disposal — 5% residue ( 1,300 tons) @\$35/ton	45,500
Public Education & Promotion — \$1/ton	26,000
Overhead (Administration, Office) — 10% of above	127,590
<b>Subtotal: Operating &amp; Maintenance Costs</b>	<b>989,701</b>
<b>Subtotal: Debt Service + O &amp; M Costs</b>	<b>1,403,493</b>
Profit @ 10%	140,349
<b>Total Annual Cost</b>	<b>1,543,843</b>
<b>Cost Per Ton</b>	<b>59</b>

Source: Franklin Associates, Ltd.

Table 4-5			
ESTIMATED SWM COSTS IN HYPOTHETICAL COMMUNITY UNDER 25,000 POPULATION			
Scenario 1: Landfilling Only			
	Household Quantity	Household Cost	
	(tons/year)	(\$/ton)	(\$/month)
Refuse Landfilled	0.962	82 to 137	6.55 to 11.00
Total SWM	0.962	82 to 137	6.55 to 11.00
Scenario 2: Curbside Recycling & Landfilling			
	Household Quantity	Household Cost	
	(tons/year)	(\$/ton)	(\$/month)
Refuse Landfilled	0.804	86 to 144	5.75 to 9.65
Net Recycling	0.158	145 to 241	1.90 to 3.20
Total SWM	0.962	96 to 160	7.65 to 12.85
Scenario 3: Curbside Recycling, Yard Waste Composting, & Landfilling			
	Household Quantity	Household Cost	
	(tons/year)	(\$/ton)	(\$/month)
Refuse Landfilled	0.544	104 to 173	4.70 to 7.85
Net Recycling	0.158	145 to 241	1.90 to 3.20
Net Yard Waste Composting	0.260	94 to 157	2.05 to 3.40
Total SWM	0.962	108 to 180	8.65 to 14.45